Tx animals. In contrast, only the posterior end of the lateral and medial meniscus showed histological changes following ACL-R (Fig. 2).

Conclusions: Overall, gross morphological changes in cartilage and meniscus were evident at the 20 week time point post ACL/MCL injury, as well as following ACL-R surgery to a lessor degree, which are indicative of future development of OA. The posterior ends of both the lateral and medial menisci exhibit more changes following both overt ligament injury and ACL-R surgery.

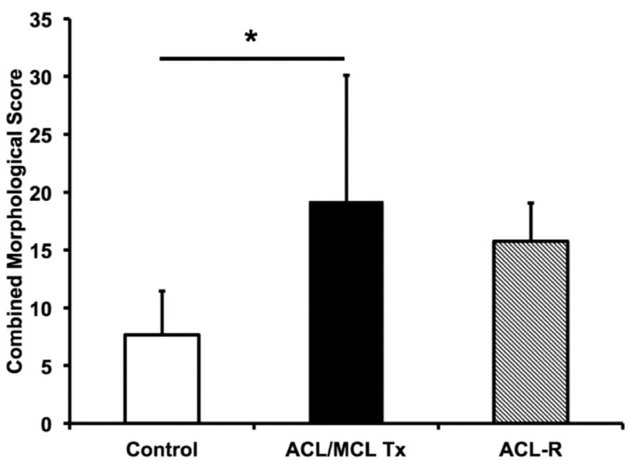

Figure 1. Combined gross morphological score at 20 weeks after ACL-R (n=4) or ACL/MCL Tx (n=5) surgery and the respective control group (n=6). * = p<0.05.

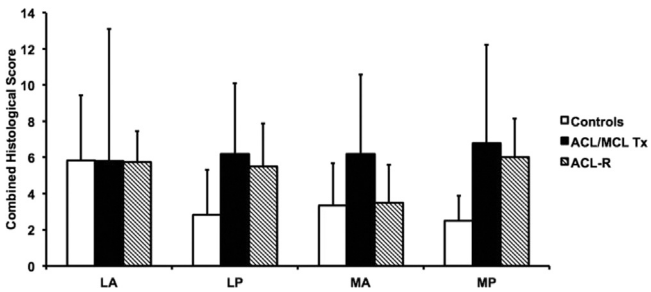

Figure 2. Combined histological score at 20 weeks after ACL-R (n=4) or ACL/MCL Tx (n=5) surgery and the respective control group (n=6) for LA, LP, MA, and MP locations in the menisci.

551
EFFECTS OF STRENGTH AND ENDURANCE TRAINING INTERVENTION ON THIGH INTERMUSCULAR AND SUBCUTANEOUS ADIPOSE TISSUE IN SARKOPENIC WOMEN

S. Griessmann †, T. Dannhauer †, M. Hudelmaier †, A. Ruhdorfer †, W. Wirth †, M. Himmer ‡, S. Ring-Dimitriou §, A. Sänger ‖, H. Kässmann ¶, C. Pirich #, F. Eckstein †. † *Paracelsus Med. Univ., Salzburg, Austria;* ‡ *Christian Doppler Klinik, Paracelsus Med. Univ., Salzburg, Austria;* § *Dept. of Sport Sci. & Kinesiology, Paris Lodron-Univ. Salzburg, Salzburg, Austria;* ‖ *Dept. of Cell Biology, Paris Lodron-Univ. Salzburg, Salzburg, Austria;* ¶ *Dept. of Nuclear Med. and Endocrinology, Landeskrankenhaus,Paracelsus Med. Univ., Salzburg, Austria;* # *Dept. of Nuclear Med. and Endocrinology, Landeskrankenhaus, Paracelsus Med. Univ., Salzburg, Austria*

Purpose: Obesity is a prominent risk factor of knee OA, and this has traditionally been attributed to mechanical effects, with more weight and load being exerted on the knee. More recent studies have additionally suggested endocrine effects, as adipokines show pro-inflammatory effects and lead to release of metallo-proteinases and growth factors that are involved in articular tissue degeneration. Exercise has been recommended by the OARSI guidelines in the treatment of knee OA, but the mechanism by which exercise causes functional benefits to the knee is not fully understood. In the current study, we explore to what extent strength and endurance training intervention is capable of reducing the inter-muscular and subcutaneous adipose tissue content.

Methods: 120 subjects were interviewed using a standardized telephone protocol and the following inclusion criteria applied: women aged 45-55 years, no history of organized sports participation, ≤1 h/week regular physical activity level, low cardio respiratory fitness. The women finally included were aged 50.8±3.2years (height 166.1±7.8cm, weight 72.8±15.7kg, BMI 26.5±5.2kg/m^2).The numbers assigned to each group were: strength training (ST) =16, endurance training (ET) =19, and autogenic training (AT; control group) =6. During the 12 week training intervention, the ST and ET groups performed exercises three times weekly for 60min; the control group (AT) met once per week. Axial MR imaging of both legs was acquired before and after the intervention, using a T1-weighted spin-echo sequence. Thigh muscle segmentation (quadriceps, hamstrings, adductors, and sartorius) had been performed previously. A semi-automated algorithm was applied to segment the thigh circumference, the area around the muscles (proximate to the fascia lata), and the femoral bone, at a level of 30% (proximal to distal) between the femoral neck and the rectus femoris tendon. The area of inter-muscular tissue (IMT), inter-muscular fat (IMF; i.e. IMT minus vessels and other non-adipose tissue), subcutaneous fat (SCF), and total fat (TOTF =IMF+SCF). Computation of SCF and TOTF was discarded in 9 participants, because either the baseline or follow-up image did not cover the entire thigh circumference. The changes between baseline and follow-up were tested for significance using a paired t-test.

Results: Baseline values across the participants were 15.0±3.6 cm^2 for IMT, 12.0±3.4 cm^2 for IMF, 128±35cm^2 for SCF, and 110±12.7 cm^2 for thigh muscle tissues. Combining participants from both intervention groups, a -3.8±11.8% decrease in IMF (p=0.03), a -5.0±6.0% decrease in SCF (p<0.001), a -5.0±6.0 % decrease in TOTF (p<0.001) and a +3.7±5.8% increase in muscle tissue (p<0.01) was observed. No obvious differences in response were seen between the strength and endurance group. The reduction of adipose tissue between IMF and SCF was correlated (r=0.46; p<0.05) and of similar magnitude. There were only small changes in the control group: -0.8±11.8% in IMF (p=0.56), +2.1±13.0% in SCF (p=0.53), +1.8±12.4% in total fat; p=0.58), and -0.9±3.9% in total muscle tissue (p=0.52).

Conclusions: This study suggests that a 12 week training intervention can effectively reduce adipose tissue mass in the thigh. Strength and endurance training appear to be similarly effective, and there were no obvious differences between training effects on IMF and SCF. Previously published measurement of thigh tissue composition with dual energy X-ray absorptiometry (DXA) from this study did not reveal significant changes in lean (muscular) or adipose tissue content during training intervention. The current findings therefore suggest that MRI-based technology may be more sensitive in demonstration changes in thigh tissue composition than standard (DXA) technology.

To be presented at the World Congress of Osteoarthritis, April 2014 in Paris, France.

552
SEX DIFFERENCES IN QUADRICEPS MUSCLE AND FEMORAL BONE CROSS SECTIONAL AREAS IN ADOLESCENT AND MATURE VOLLEYBALL ATHLETES

F. Eckstein †, H. Boeth ‡, G. Diederichs §, S. Cotofana †, M. Hudelmaier †, W. Wirth †, M. Hofmann-Amtenbrink ‖, G. Duda ¶. † *Paracelsus Med. Univ., Salzburg, Austria;* ‡ *Julius Wolff Inst., Charité – Univ.smedizin Berlin, Ctr. for Sports Sci. and Sports Med. Berlin, Berlin, Germany;* § *Dept. of Radiology, Charité - Univ.smedizin Berlin, Berlin, Germany;* ‖ *Mat Search Consulting Hofmann, Pully, Switzerland, Pully, Switzerland;* ¶ *Julius Wolff Inst., Charité – Univ.smedizin Berlin, Ctr. for Sports Sci. and Sports Med., Berlin, Germany*

Purpose: Adequate muscle strength is important for proper knee function. It is also well known that quadriceps muscle strength and anatomical cross sectional areas (CSA) are compromised in knee OA. To what extent muscle atrophy is related to pain or central inhibition, and to what extent lack of muscle strength and mass is responsible for incident and progressive knee symptoms or radiographic change in

knee OA is controversial. However, recent findings indicate that there may be a relationship between muscle and incident or progressive symptoms and structural change in women but not in men. Yet, little is known about sex differences of muscle development at various stages of human development, particularly in relation to local bone size.
Methods: 20 young (baseline age 16.0±0.6y) and 20 mature (46.3±4.7y) top volleyball athletes were studied: 10 young men (BMI 22.3±0.9) and women (20.9±2.0), and 10 mature men (BMI 26±2.6) and women (22.7±1.9). The adolescent athletes trained twice per day (each session approx. 2 hours), and the former (mature) volleyball athletes trained about twice per week. Axial MR images (T1-weighed spin echo) of both thighs were acquired at baseline and 2 year follow-up, extending from the femoral neck proximally to the quadriceps tendon distally. Quadriceps muscle, total femoral and cortical bone CSAs were determined in the dominant leg (the one used for takeoff), in an MR image that was located 30% from proximal to distal (where quadriceps CSA was previously shown to correlate best with quadriceps volume). Differences between men and women and between adolescent and mature athletes were explored using unpaired t-tests, and longitudinal difference during the 2-year observation period using paired t-tests.
Results: At baseline, men had significantly ($p<0.001$) greater quadriceps, total femoral bone, and cortical femoral bone CSAs than women, both in adolescent and in mature athletes (Table 1).However, the ratio between quadriceps vs. total femoral (or cortical) femoral bone area did not differ significantly between men and women at either age (Table 1; $p>0.25$). Mature women and men had smaller quadriceps ACSAs than the adolescent men and women (Table 1), but the difference only reached statistical significance in the women ($p<0.05$). The ratio of quadriceps vs. total and cortical femoral bone area was significantly ($p<0.05$) smaller in mature than in adolescent athletes, both in men and women (Table 1). No difference in the percent cortical (of total) femoral area was seen between sexes or age groups (Table 1; $p>0.18$). No significant changes in quadriceps CSA were observed during the 2 year observation period, although the increase in adolescent men (5.0±7.1%) reached borderline significance ($p=0.08$). A significant increase in cortical (3.2±2.8%) and total femoral area (2.8±2.6%) was noted in adolescent men (both $p<0.01$), but not in adolescent women ($p>0.24$) or mature study athletes ($p>0.23$). The increase in quadriceps CSA in the adolescent men was associated with the increase in femoral cortical bone area (Pearson correlation coefficient $r=0.70$; 95%CI -0.02,0.94; $p=0.06$).

Table 1
Muscle and bone CSA in volleyball athletes (W = women; M = men): mean±SD at baseline

	Adoles. W	Adoles. M	Mature W	Mature M
Quadriceps (cm2)	67.7±9.9	87.2±7.5	59.6±5.3	80.3±7.6
Tot fem bone (cm2)	6.10±0.88	7.77±0.98	6.24±0.67	8.12±0.80
Radio (Quad/tot fem)	11.16±1.41	11.32±1.17	9.66±1.30	9.96±1.17
Cort fem bone (cm2)	4.80±0.63	6.11±0.66	5.03±0.40	6.40±0.63
% Cort/tot fem bone (%)	78.9±4.6	79.0±6.2	80.9±4.2	78.9±1.8

Conclusions: These findings reveal sex-specific muscle vs. bone relationships in active adults at different stages of maturation. It is important to note that the observed relationships may be specific to subjects with intense training and loading histories, and may not apply to less active individuals. The observed changes of muscle and bone tissue in adolescent men appear to be coupled, whereas no (more) change was observed in women at this stage of maturity. Although men obviously had larger quadriceps and bone CSAs than women, the ratio between muscle and bone tissue did not display sex-specific differences at either stage of maturity. The cross sectional results suggests that in adulthood (i.e. 30 years after adolescence) approx. 92% of the muscle mass of very well trained young men, and approx. 88% of that of young women, can be maintained when regular sportive activity is continued. Future studies need to explore to what extent these relationships may be relevant to the incidence and progression of symptoms and degenerative structural change in knee OA.

553
THE DIFFERENCES ON EXTRACELLULAR MATRIX AMONG EACH PORTION OF MENISCUS

X. Zhang, II. *Graduate Sch. of Medcine, Kyoto Univ., Kyoto, Japan*

Purpose: Meniscus consist of fibrochondrocytes embedded in an extracellular matrix composed of a hydrophilic proteoglycan gel enmeshed in dense network of type I collagen. However it is not clear that extracellular matrix in meniscus. Therefore the purpose of this study was to analyze differences in the extracellular composition and collagen orientation of the central and peripheral portions of the meniscus.
Methods: Six-month-old pigs were used for current study. The menisci were removed from the six knees. According to anatomical feature of meniscus, each meniscus was divided into six portions (central and peripheral portion of anterior, middle and posteria part). The histologic analysis, biochemical analysis, scanning electron microscope (SEM) and compression test were performed. After the samples were embedded in paraffin, they were sectioned to 6μm. The sections were stained with Hematoxylin/Eosin (HE), SafraninO/Fast Green, and Picrosirius Red. The samples were observed with SEM. For biochemical analysis, samples were digested by papain and HCL for DMMB assay and hydroxyproline assay. Glycosaminoglycan (GAG) and collagen content were quantified by using microplate reader. For biomechanical analysis, 1mm thick of samples were cut from six portions of meniscus. Then we tested the peak stress of 50% stain. All statistical analyses were performed by the two-sample t-test method.
Results: Blood vessel in peripheral portion was more than in central portion. Picrosirius Red stain showed higher density of collagen in peripheral portion. Furthermore some collagen fibers parallel to surface near the surface to femur and tibia were observed. There were some large collagen fibers in peripheral portion(Fig.1). Glycosaminoglycan was stained with red in Safranin-O/Fast Green in central portion obviously(Fig.2). As the result of Picrosirius Red stain, the higher density of collagen fiber in peripheral portion was seen by SEM observation(Fig.1). The layer of surface to femur and tibia were different with internal structure of meniscus. Most of collagen orientation of internal structure was parallel fibers which perpendicular to cut surface. However the collagen fibers in surface to femur and tibia were looser than internal collagen fibers. The parallel collagen layers were observed in surface area. In tibia side, some crimp construction was observed. DMMB assay showed that glycosaminoglycan content in central portion was more than in peripheral portion ($p < 0.05$). In accord with the result of Picsirius Red stain and SEM, more collagen content in the peripheral portion was quantitated by hydroxyproline assay ($p < 0.05$))(Fig.3). In compression test, the result reflected central portion was stronger against mechanical stimulation but only posterior portion of medial meniscus and middle portion of lateral meniscus were significant ($P < 0.05$).
Conclusions: Collagen content in peripheral portion was more than in central portion. On the contrary, glycosaminoglycan content in central content was more than in peripheral portion. IN this study, there are not significant differences among anterior, middle and posterior portion. The difference of extracellular matrix contents reflected the resistance against mechanical strength. These results may leads to understanding for biology of meniscus.

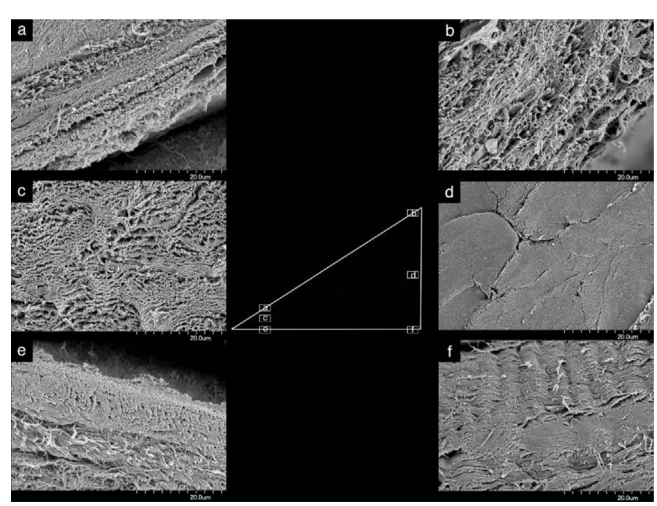

Fig.1, This is result of SEM of medial meniscus. In the middle layer, the density of collagen fibers in the peripheral portion was more than in central portion. In the surface, parallel collagen fibers could be observed.